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GB 2288680 A GB 2250967 A US 4288819 A

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(54) A sensing system for a vehicle

(57) A sensing system for a vehicle comprises a CCD element 26, a plurality of focusing means 32 facing in different directions for receiving images from respective parts of the vehicle and directing them onto different parts of a single CCD element. Image processing is used to process the images from the different parts of the vehicle and control several functions. The focusing means may comprise lenses 32 and a prism 34 or curved reflectors (52, fig 3) apertures (54). A sensor mounted inside the passenger compartment on the roof obtains images of the front and rear screens to detect mist thereon to control windscreen wipers or heaters, of seat belt catches to determine whether passengers have their seat belts fastened, of passengers to determine their size or head position to control air bags inflation in a crash, and of movement inside and outside the vehicle to identify intrusion.

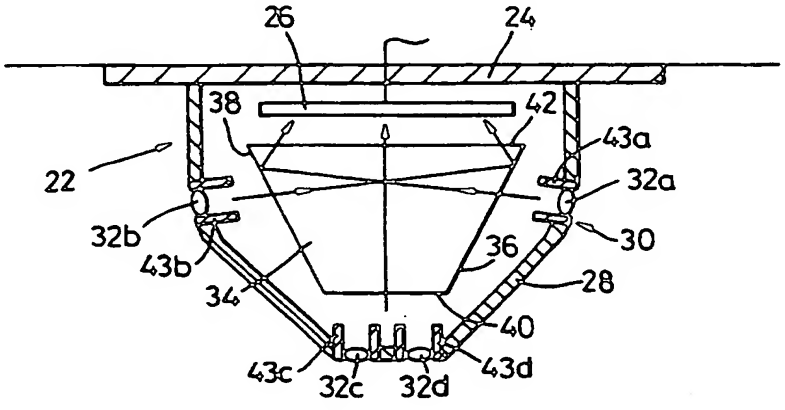

Fig. 2

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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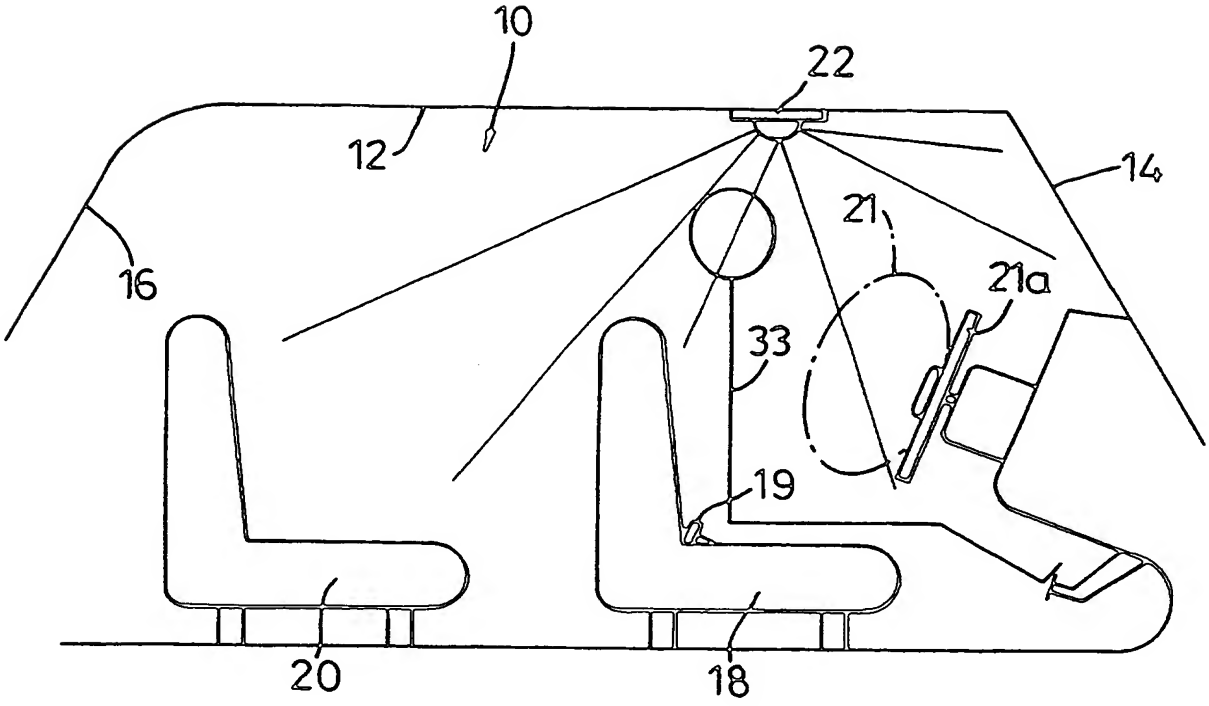
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Fig. 1

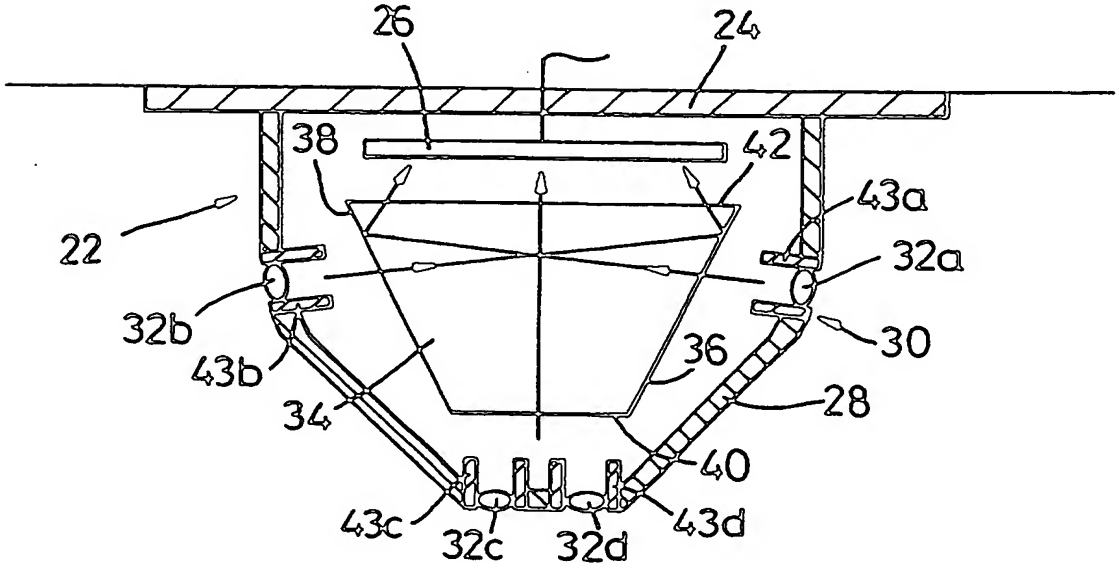
26
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Fig. 2

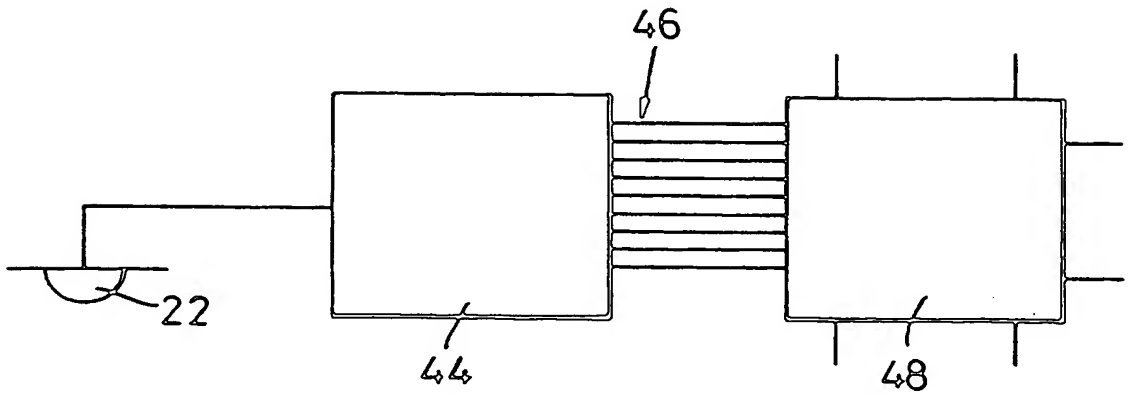

Fig. 3

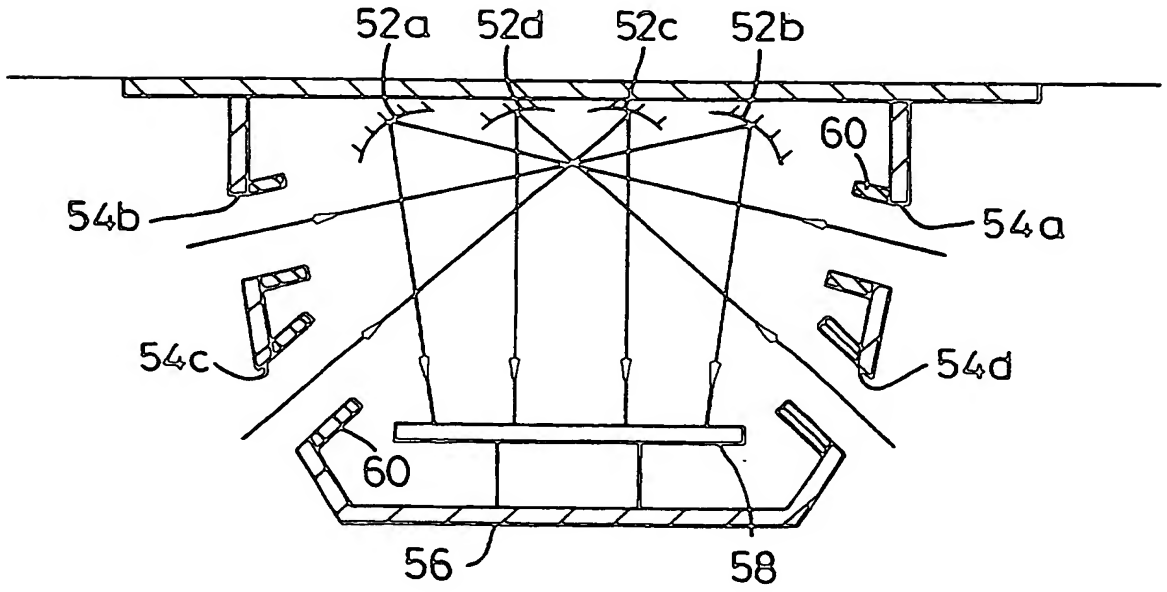

Fig. 4

A Sensing System for a Vehicle

The present invention relates to sensing systems for vehicles.

It is known, for example from GB 2 288 680 and DE 44 17 385 to use relatively sensitive image sensing devices such as C.C.D. cameras in vehicles, in order to perform various functions such as recognition of passengers and detection of water on windscreens. However, these devices tend to be prohibitively expensive except for the most expensive vehicles.

Accordingly the present invention provides a control system for controlling a vehicle subsystem, the control system comprising control means arranged to produce signals for controlling the subsystem, and sensing means comprising a sensing element, and means for focusing light from respective areas of the vehicle and directing the light from each of said areas onto a respective area of the sensing element.

The control system may be used to control a plurality of subsystems of the vehicle, such as a security system and an airbag system, thereby making it more cost effective.

The focusing means may comprise lenses or mirrors. The images may be directed onto the C.C.D. element by separate directing means, such as a prism, or by the focusing means.

The present invention further provides control system for controlling a vehicle subsystem, the control system comprising control means arranged to produce signals for controlling the subsystem, and sensing means comprising a sensing element, and two focusing means, wherein the focusing means are arranged to focus light from an object to form two respective images of the object for sensing by the sensing element, and the control means is arranged to process the two images to determine the distance of the object from the sensor and control the subsystem in a manner determined at least partly by said distance.

This arrangement further increases the number of applications for the sensor unit, and can enable, for example, accurate location of a driver's head to control airbag deployment, or determination of the position of detected movements for use in operating a security system.

The present invention still further provides a system for clearing mist from a vehicle window, the system comprising mist clearing means operable to clear mist from the vehicle window, control means for controlling operation of the mist clearing means, and viewing means arranged to view a scene through the window and form an image thereof, the control means being arranged to determine from said image when misting of the window has occurred, and, when it has so determined, to operate the mist clearing means.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows the interior of a vehicle including a sensing system according to a first embodiment of the invention;

Figure 2 is a section through a sensing unit of the system of Figure 1;

Figure 3 shows part of an electrical system of the vehicle of Figure 1; and

Figure 4 is a section through a sensing unit of a second embodiment of the invention.

Referring to Figures 1 and 2 a vehicle passenger compartment 10 has a roof 12, a front windscreen 14, a rear windscreen 16, a pair of front seats 18 with front seat belt catches 19 and a rear seat 20. A driver's airbag is mounted on the vehicle steering wheel 21a. A sensor unit 22 is mounted inside the passenger compartment 10 on the roof 12 in the centre of the vehicle over the front seats 18.

The sensor unit comprises a base 24 with a C.C.D. camera element 26 mounted on it. A domed housing 28 is also mounted on the base 24 and has

a plurality of apertures 30 in it in which lenses 32 are supported. A prism 34 is mounted in the housing for directing light from the lenses 32 onto the C.C.D. element 26. The lenses include a first lens 32a which faces forwards towards the windscreen 14, a second lens 32b which faces backwards towards the rear windscreen 16, and a pair of lenses 32c, 32d which face downwards towards the driver's seat 18 and provide binocular vision of the driver 33. Further pairs of lenses (not shown) are provided which face towards the front passenger's seat 18 and each of the rear seats 20. Each of the lenses is arranged to receive light from the area of the vehicle towards which it faces. The prism 34 is shaped such that it directs the light from each of the areas of the vehicle onto a respective part of the C.C.D. element. For example, light entering the vehicle through the front windscreen 14 passes through a front surface 36 of the prism, and is reflected off a rear surface 38 of the prism onto one part of the C.C.D. element 26 where it forms an image of a scene including part of the front windscreen 14, any water thereon, and whatever is in front of the vehicle and visible through the front windscreen 14. Light from the rear windscreen 16 passes through the rear surface 38 of the prism, and is reflected off the front surface 36 onto another part of the C.C.D. element, where it forms an image of part of the rear windscreen 16 and any water thereon. Light from the direction of the driver's seat passes upwards through the pair of lenses 32c, 32d, straight through the parallel bottom and top surfaces 40, 42 of the prism 34 and onto

another two parts of the C.C.D. element 26 where it forms two separate images of the driver 33. The pairs of lenses (not shown) facing the front passenger and rear seats 18, 20 produce images on further areas of the C.C.D. element 26 of the seats or any passengers sitting on them. A tubular light shield 43a, 43b, 43c, 43d, is provided around each of the lenses 32 which restricts the angle at which light can pass through lens, thereby ensuring that only light from the desired area can pass through the lenses and reach the C.C.D. element.

Operation of the vehicle electrical system including the sensor unit 22 will now be described with reference to Figure 3. The sensor unit 22 is connected to an image processing and logic unit 44 which analyses the images on the various areas of the C.C.D. element 26, compares them with images stored in memory, or analyses their characteristics, to determine whether certain conditions exist, and produces a series of signals at outputs 46 which each indicate whether a particular condition exists or not. These signals are input to a control unit 48 which controls the operation of various features if the vehicle including the windscreen wipers for the front and rear screens, the security system, the airbags, and the ventilation system as described below.

The images of each of the seat belt catches 19. and the front seats 18 are monitored and, if either of the seats is occupied without its respective catch being fastened, a seat belt warning light is lit as a warning.

The two images of the driver 33 produced by the two lenses 32c. 32d pointing towards the driver's seat will, if the seat is occupied, include images of the driver. These two images can be compared and processed by the logic unit 44 to determine the distance of each object in the image or each part of the driver from the sensor. This is done by comparing the position of the object within the two images, the difference in the two positions giving an indication of the distance between the object and the sensor. Thus, using this 'binocular' type viewing process, the exact position of, for example, the driver's head can be determined.

Referring to Figure 1, it will be appreciated that the height of the driver's head above the driver's seat will affect the way in which the airbag 21 needs to be operated for maximum safety of the driver. In the example shown, the airbag is positioned such that a short driver's head is closer to it than a tall driver's head. Thus, for a short driver it is desirable to inflate the airbag more quickly than for a tall driver. The control unit 48 can thus control the airbag actuation to suit the height of the driver.

Moreover, the logic unit 44 is arranged to determine the nature and position of the occupant of the front passenger seat. It can therefore distinguish whether the front passenger seat is occupied by a normal sized adult, a small child, or a baby in a rear-facing car seat. Actuation of the passenger side airbag can then be controlled to take this information into account.

The image produced by the forward facing lens 32a will be of the view through the front windscreen of the vehicle. This will normally include the vehicle bonnet. The normal outline of the vehicle bonnet is stored in memory in the image processing unit 44. The view of the bonnet can therefore be monitored and, if all or part of it becomes indistinct, or features of the stored image cease to be present in the viewed image, this can be taken as an indication that the windscreen has become misted over. In response to this the control unit 48 controls the vehicle's heating and ventilation system so as to clear the mist from the windscreen. It does this by actuating control flaps in the ventilating system to allow fresh air from outside the vehicle to enter the passenger compartment, and directing a proportion of that air towards the windscreen.

It will be appreciated that other factors apart from misting could lead to an unclear image of the vehicle bonnet. However, in order to overcome this problem use can be made of the fact that mist-covered glass transmits a

high proportion of the light incident on it. although that light is scattered and diffracted. The control unit is therefore arranged to monitor the total amount of light received by the forward facing lens 32a. If the image becomes indistinct while the total amount of light received remains high, this indicates that the windscreen has misted over. If the total amount of light received is low, then this indicates simply that there is not sufficient light to produce a clear image, or possibly that an opaque object is obscuring the view of the lens 32a. and the ventilation system is not affected. The comparison of image clarity and total light level can be carried out for separate parts of the field of view of the forward facing lens 32a to determine whether any part of the windscreen has become misted over, and the ventilation system adjusted accordingly.

As well as controlling the ventilation system, the control unit 48 is also arranged to turn on a screen heater, comprising a thin electrically conductive film incorporated in the windscreen, to help clear the windscreen if mist is detected.

For the rear screen 16, there is no specific object outside the screen which can be used as a reference to determine whether the rear screen is misted or clear. However there will be a significant difference between the image produced by a misted screen and that produced by a clear screen. A misted screen will produce a relatively even distribution of light with no

clear features discernible in it. A clear screen will produce an image with contrasting light and dark areas and sharp edges and. when the vehicle is moving, these features will move within the image. These features can be recognized by means of image processing and the control unit 48 can therefore determine whether the rear screen is misted or not. As with the front screen, the total light level can be used to distinguish mist from an opaque object. When misting is detected, the control unit operates a rear screen heater to clear the rear screen.

The control unit 48 is also connected to a control unit for a security system for the vehicle. The security system will generally only be activated when the vehicle is stationary and unoccupied, and the sensor unit 22 can therefore be used solely for security purposes. In this mode the main function of the sensor unit 22 is to monitor for movement within the vehicle, which would indicate the presence of an intruder and be used to actuate an alarm. However, because the sensor detects light of optical wavelengths it will detect through the windows movement of things outside the vehicle, such as people walking past. This is because the field of the lenses, including those monitoring the vehicle seats and their occupants, needs to be quite wide to cover all likely positions of, for example, a passenger's head, and will therefore include the side windows of the vehicle and things seen through them.

With this system, however, the 'binocular' viewing ability of the sensor unit 22 enables the exact position of a moving object to be determined. The image processing unit 44 can therefore determine whether the moving object detected is inside or outside the vehicle. The security control unit can therefore be arranged to trigger an alarm if movement is detected within the vehicle when the security system is activated, but not if movement is detected which is determined to be outside the vehicle.

Referring to Figure 4, in a second embodiment of the invention the lenses and prism are replaced by a plurality of concave curved mirrors 52a, 52b, 52c, 52d, each of which receives light from a respective aperture 54a, 54b, 54c, 54d in the housing 56 and reflects and focuses it as an image directly onto a respective area on the C.C.D. element 58. The mirrors are shaped and arranged such that each one of them will only reflect light from one of the apertures 54 onto the C.C.D. element, and light reflected from each mirror will only impinge upon a part of the C.C.D. element. This means that there will be separate areas of the C.C.D. element each with only one image directed onto it. Tubular light shields 60 are provided around each of the apertures 54. These restrict the angle at which light can pass through the apertures 54, and can be made of sufficient length to ensure that light from each aperture 54 can only reach one of the mirrors 52. This would be useful if it were not otherwise possible to shape the mirrors as described above to avoid overlapping of images on the C.C.D.

element. They can also restrict the area of the vehicle from which light can be passed through each aperture 54 to its respective mirror 52, and therefore the area of which an image will be formed on the C.C.D. element.

It will be appreciated that the arrangement shown could be modified by having light from two or more of the apertures focused onto different parts of the C.C.D. element by the same mirror, or by having two or more mirrors receiving light from different directions through the same aperture, and focusing it onto different parts of the C.C.D. element.

CLAIMS

1. A control system for controlling a vehicle subsystem, the control system comprising control means arranged to produce signals for controlling the subsystem, and sensing means comprising a sensing element, and means for focusing light from respective areas of the vehicle and directing the light from each of said areas onto a respective area of the sensing element.

2. A control system according to claim 1 wherein said means is arranged to direct light from at least two of said areas onto different parts of the sensing element.

3. A control system according to claim 1 or claim 2 wherein said means comprises focusing means for focusing the light, and directing means for directing the light onto the image sensing element.

4. A sensing system according to claim 3 wherein the directing means comprises a prism.

5. A sensing system according to claim 4 wherein the prism is arranged to direct light from a plurality of said areas onto the sensing element.

6. A sensing system according to claim 5 wherein the prism has at least one surface arranged to transmit light from one of said areas and to reflect light from another of said areas.

7. A system according to any one of claims 3 to 6 wherein the focusing means comprises at least one lens.

8. A system according to claim 7 wherein the sensing means further comprises a housing enclosing the prism, said at least one lens being mounted in an aperture in the housing.

9. A sensing system according to claim 8 further comprising light shielding means for restricting the angle at which light can pass through at least one of the apertures.

10. A system according to claim 9 wherein said light shielding means is substantially tubular.

11. A system according to any foregoing claim wherein at least on of the focusing means comprises a curved mirror.

12. A sensing system according to claim 11 wherein the mirror also acts as directing means to direct its image towards the image sensing element.

13. A control system for controlling a vehicle subsystem, the control system comprising control means arranged to produce signals for controlling the subsystem, and sensing means comprising a sensing element, and two focusing means, wherein the focusing means are arranged to focus light from an object to form two respective images of the object for sensing by the sensing element, and the control means is arranged to process the two images to determine the distance of the object from the sensor and control the subsystem in a manner determined at least partly by said distance.

14. A system according to claim 13 wherein the subsystem is an airbag control system.

15. A system according to claim 14 wherein the sensing means is arranged to form said images of a part of an occupant of the vehicle.

16. A system according to claim 15 wherein the sensing means is arranged to form said images of the head of an occupant of the vehicle and the control means is arranged to control the airbag system in a manner determined at least partly by the position of said head.

17. A system according to claim 16 wherein the control means is arranged to control the airbag system in a manner determined at least partly by the height of said head.

18. A system according to claim 16 or claim 17 wherein the control means is arranged to control the airbag system in a manner determined at least partly by the lateral position of said head.

19. A system according to claim 13 wherein said subsystem is a vehicle security system.

20. A system according to claim 19 wherein the sensing means is arranged to form images of objects both inside and outside the vehicle, and to determine from an estimated distance of the object whether it is inside or outside the vehicle.

21. A system according to claim 20 wherein the control means is arranged to actuate the security system in a predetermined manner if, in a predetermined set of circumstances, a detected object is determined to be inside the vehicle, but not so to actuate the security system if the object is determined to be outside the vehicle.

22. A system for clearing mist from a vehicle window, the system comprising mist clearing means operable to clear mist from the vehicle window, control means for controlling operation of the mist clearing means, and viewing means arranged to view a scene through the window and form an image thereof, the control means being arranged to determine from said image when misting of the window has occurred, and, when it has so determined, to operate the mist clearing means.

23. A system according to claim 22 wherein the mist clearing means comprises air controlling means for controlling the flow of air into the passenger compartment.

24. A system according to claim 23 which is arranged to increase the amount of air directed towards said window when said misting is detected.

25. A system according to claim 23 or claim 24 wherein the air controlling means controls the amounts of fresh air and recirculated air entering the passenger compartment and the control means is arranged to increase the amount of fresh air entering the passenger compartment when said misting is detected.

26. A system according to any one of claims 23 to 25 wherein the mist clearing means comprises a heating means for heating the window.

27. A system according to any one of claims 23 to 26 wherein said scene includes a part of the vehicle on the opposite side of the window to the viewing means, and the control means is arranged to compare the image of said part detected by the viewing means with an image of said part stored in memory.

28. A system according to claim 27 wherein the viewing means is inside the passenger compartment and said part of the vehicle is outside the passenger compartment.

29. A system according to any one of claims 22 to 28 wherein the control means is arranged to detect the total level of light received through at least an area of the window and to use the detected light level to help determine whether the window is misted.

30. A sensing system according to any foregoing claim wherein the image sensing element comprises an array of light sensitive devices.

31. A sensing system according to claim 10 wherein the image sensing element is a C.C.D. camera element.

The Patent Office

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Application No: GB 9706129.5
Claims searched: 1 to 21

Examiner: Bob Clark
Date of search: 17 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Int Cl (Ed.6): B60R 22/48, 25/10; B60S 1/08; G01J 1/02, 1/04, 1/06; G06T 7/00; G08B 13/18, 13/181, 13/189, 13/194, 13/196

Other: Online database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2288680 A	(MERCEDES-BENZ) Page 10	1-3, 7, 30
X	GB2250967 A	(GEC-FERRANTI) Whole document	1-3, 7, 30
X	US4625329	(ISHIKAWA et al.) See abstract	1-3, 7, 30
X	US4288819	(WILLIAMS) Whole document	1-3, 7

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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Application No: GB 9706129.5 Examiner: Bob Clark
Claims searched: 22-29 Date of search: 28 August 1997

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Int Cl (Ed.6): B60H 1/00; B60S 1/02, 1/54; G06T 7/00; H05B 3/84

Other: Online database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	None	

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X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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